ing paper that a distinguished public man had arrived in San Francisco late in the evening, and, fatigued with his journey, had retired at seven o'clock, would give the Eastern reader a sense of the utter strangeness of keeping a time three hours different from local time.

Any action for the establishment of standards of time over the country must begin by securing the active cooperation of the telegraph companies. The most influential of these companies has been traditionally public-spirited in allowing the use of its wires for scientific purposes, often at considerable expense to itself. The service of transmitting time occupies at present such an extremely small proportion of its ordinary business that the company has not as yet an officer of its service empowered to carry out the details necessary for such time-distributions as have been already discussed. If, however, the committees referred to could prepare a scheme that was thoroughly practical, and agree upon a uniformity of details which should not seriously interfere with the ordinary business of this or any other company, it is believed that the company would find it to their own interest to establish a regular system of procedure to govern their action in the case of observatories in different parts of the country which desire to secure their services in transmitting time-signals. In consideration of the assumption of responsibility and the efforts at introduction made by the observatory, the company would probably be found willing to so adjust their charges that it would prove to be entirely practicable for the various observatories to secure a large patronage for the services emanating from them without the financial burden seeming an undue amount.—*North Am. Rev.*

[*Continued from page 270.*]

THE UNITY OF NATURE.

BY THE DUKE OF ARGYLL.

III.

ANIMAL INSTINCT IN ITS RELATIONS TO THE MIND OF MAN.

All the knowledge and all the resource of mind which is involved in these instincts is a reflection of some Agency which is outside the creatures which exhibit them. In this respect it may be said with truth that they are machines. But then they are machines with this peculiarity, that they not only reflect, but also in various measures and degrees partake of, the attributes of mind. It is always by some one or other of these attributes that they are guided—by fear, or by desire, or by affection, or by mental impulses which go straight to the results of reasoning without its processes. That all these mental attributes are connected with a physical organism which is constructed on mechanical principles, is not a matter of speculation. It is an obvious and acknowledged fact. The question is not whether, in this sense, animals are machines, but whether the work which has been assigned to them does or does not partake in various measures and degrees of the various qualities which we recognize in ourselves as the qualities of sensation, of consciousness and of will.

On this matter it seems clear to me that Professor Huxley has seriously misconceived the doctrine of Descartes. It is true that he quotes a passage as representing the view of "orthodox Cartesians," in which it is asserted that animals "eat without pleasure and cry without pain," and that they "desire" nothing as well as "know" nothing. But this passage is quoted, not from Descartes, but from Malebranche. Malebranche was a great man; but on this subject he was the disciple and not the master; and it seems almost a law that no utterance of original genius can long escape the fate of being travestied and turned to nonsense by those who take it up at second hand. Descartes' letter to Moore, of the 5th February, 1649, proves conclusively that he fully recognized in the lower animals the existence of all the affections of mind except "Thought" (*la Pensée*), or Reason, properly so called. He ascribes to them the mental emotions of fear, of anger, and of desire, as well as all the sensations of pleasure and of pain. What he means by thought is clearly indicated in the passage in which he points to Language as the peculiar product and the sole index of Thought—Language, of course, taken in its broadest sense, signifying any system of signs by which general or abstract ideas are expressed and communicated. This, as Descartes truly says, is never wanting, even in the lowest of men, and is never present in the highest of the brutes. But he distinctly says that the lower animals, having the same organs of sight, of hearing, of taste, etc., with ourselves, have also the same sensations, as well as the same affections of anger, of fear, and of desire—affections which, being mental, he ascribes to a lower kind or class of Soul, an "âme corporelle.' Descartes, therefore, was not guilty of confounding the two elements of meaning which are involved in the word machine—that element which attaches to all machines made by man as consisting of dead non-sentient matter—and that other element of meaning which may be legitimately attached to structures which have been made, not to simulate, but really to possess all the essential properties of Life. "Il faut pourtant remarquer," says Descartes, emphatically, "que je parle de la pensée *non de la vie, ou de sentiment.*"[1]

The experiments quoted by Professor Huxley and by other Physiologists, on the phenomena of vivisection, cannot alter or modify the general conclusions which have long been reached on the unquestionable connection between all the functions of Life and the mechanism of the body. The question remains, whether the ascertainment of this connection in its details can alter our conceptions of what Life and sensation are. No light is thrown on this question by cutting out from an organism certain parts of the machinery which are known to be the seat of consciousness, and then finding that the animal is still capable of certain movements which are usually indicative of sensation and of purpose. Surely the reasoning is bad which argues that because a given movement goes on after the animal has been mutilated, this movement must therefore continue to possess all the same elements of character which accompanied it when the animal was complete. The character of purpose in one sense or another belongs to all organic movements whatever—to those which are independent of conscious sensation, or of the will, as well as to those which are voluntary and intentional. The only difference between the two classes of movement is, that in the case of one of them the purpose is wholly outside the animal, and that in the case of the other class of movement the animal has faculties which make it, however indirectly, a conscious participant or agent in the purpose, or in some part of the purpose, to be subserved. The action of the heart in animals is as certainly "purposive" in its character as the act of eating and deglutition. In the one the animal is wholly passive—has no sensation, no consciousness, however dim. In the other movement the animal is an active agent, is impelled to it by desires which are mental affections, and receives from it the appropriate pleasure which belongs to consciousness and sensation. These powers themselves, however, depend, each of them, on certain bits and parts of the animal mechanism; and if these parts can be separately injured or destroyed, it is intelligible enough that consciousness and sensation may be severed for a time from the movements which they ordinarily accompany and direct. The success of such an experiment may teach us much on the details of a general truth which has long been known—that conscious sensation is, so far as our experience goes, inseparably dependent upon the mechanism of an organic structure. But it cannot in the slightest degree change or modify our conception of what conscious sensation in itself is. It is mechanical exactly in the same sense in which we have long known it to be so—that is to say, it is the result of life working in and through a structure which has been made to exhibit and embody its peculiar gifts and powers.

Considering now that the body of man is one in structure with the body of all vertebrate animals—considering that, as we rise from the lowest of these to him who is the highest, we see this same structure elaborated into closer and closer likeness, until every part corresponds, bone to bone, tissue to tissue, organ to organ—I cannot doubt that Man is a machine, precisely in the same sense in which animals are machines.

[1] "Œuvres de Descartes," Cousin, vol. x. p. 205 *et seq.*

If it is no contradiction in terms to speak of a machine which has been made to feel and to see, and to hear and to desire, neither need there be any contradiction in terms in speaking of a machine which has been made to think, and to reflect, and to reason. These are, indeed, powers so much higher than the others that they may be considered as different in kind. But this difference, however great it may be, whether we look at it in its practical results, or as a question of classification, is certainly not a difference which throws any doubt upon the fact that all these higher powers are, equally with the lowest, dependent in this world on special arrangements in a material organism. It seems to me that the very fact of the question being raised whether Man can be called a machine in the same sense as that in which alone the lower animals can properly be so described, is a proof that the questioner believes the lower animals to be machines in a sense in which it is not true. Such manifestations of mental attributes as they display are the true and veritable index of powers which are really by them possessed and enjoyed. The notion that, because these powers depend on an organic apparatus, they are therefore not what they seem to be, is a mere confusion of thought. On the other hand, when this comes to be thoroughly understood, the notion that Man's peculiar powers are lowered and dishonored when they are conceived to stand in any similar relation to the body must be equally abandoned, as partaking of the same fallacy. If the sensation of pleasure and of pain, and the more purely mental manifestations of fear and of affection have in the lower animals some inseparable connection with an organic apparatus, I do not see why we should be jealous of admitting that the still higher powers of self-consciousness and reason have in Man a similar connection with the same kind of mechanism. The nature of this connection in itself is equally mysterious, and, indeed, inconceivable in either case. As a matter of fact, we have precisely the same evidence as to both. If painful and pleasurable emotions can be destroyed by the cutting of a nerve, so also can the powers of memory and of reason be destroyed by any injury or disease which affects some bits of the substance of the brain. If, however, the fact of this mysterious connection be so interpreted as to make us alter our conceptions of what self-consciousness, and reason, and all mental manifestations in themselves are, then indeed we man well be jealous—not of the facts, but of the illogical use which is often made of them. Self-consciousness and reason and affection, and fear and pain and pleasure, are in themselves exactly what we have always known them to be ; and no discovery as to the physical apparatus with which they are somehow connected can throw the smallest obscurity on the criteria by which they are to be identified as so many different phenomena of mind. Our old knowledge of the work done is in no way altered by any new information as to the apparatus by which it is effected. This is the error commttted by those who think they can found a new Psychology on the knife. They seem to think that sensation and memory, and reasoning and will, become something different from that which thiterto we have known them to be, when we have found out that each of these powers may have some special "seat" or "organ" in the body. This, however, is a pure delusion. The known element in psychology is always the nature of the mental faculty; the unknown element is always the nature of its connection with any organ. We know the operations of our own minds with a fullness and realty which does not belong to any other knowledge whatever. We do not know the bond of union between these operations and the brain, except as a sort of external and wholly unintelligible fact. Remembering all this, then, we need not fear or shrink from the admission that Man is a reasoning and self-conscious machine, just in the same sense in which the lower animals are machines which have been made to exhibit and possess certain mental faculties of a lower class.

But what of this? What is the value of this conclusion? Its value would be small indeed if this conception of ourselves as machines could be defended only as a harmless metaphor. But there is far more to be said for it and about it than this. The conception is one which is not only harmless, but profoundly true, as all metaphors are when they are securely rooted in the Homologies of Nature. There is much to be learnt from that aspect of mind in which we regard its powers as intimately connected with a material apparatus, and from that aspect of our own bodies in which they are regarded as one in structure with the bodies of the brutes. Surely it would be a strange object of ambition to try to think that we are not included in the vast system of adjustment which we have thus traced in them ; that our nobler faculties have no share in the secure and wonderful guarantee which it affords for the truthfulness of all mental gifts. It is well that we should place a high estimate on the superiority of the powers which we possess ; and that the distinction, with all its consequences, between self-conscious Reason and the comparatively simple perceptions of the beasts, should be ever kept in view. But it is not well that we should omit from that estimate a common element of immense importance which belongs to both, and the value of which becomes immeasurably greater in its connection with our special gifts. That element is the element of adjustment—the element which suggests the idea of an apparatus—the element which constitutes all our higher faculties the index and the result of a pre-adjustment harmony. In the light of this conception we can see a new meaning in our "place in Nature;" that place which, so far as our bodily organs are concerned, assigns to us simply a front rank among the creatures which are endowed with Life. It is in virtue of that place and association that we may be best assured that our special gifts have the same relation to the higher realities of Nature which the lower faculties of the beasts have to the lower realities of tne physical world. Whatever we have that is peculiar to ourselves is built up on the same firm foundation on which all animal instincts rests. It is often said that we can never really know what unreasoning instinct is, because we can never enter into an animal mind, and see what is working there. Men are so apt to be arrogant in philosophy that it seems almost wrong to deprecate even any semblance of the consciousness of ignorance. But it were much to be desired that the modesty of philosophers would come in the right places. I hold that we can know, and can almost thoroughly understand, the instincts of the lower animals ; and this for the best of all reasons, that we are ourselves animals, whatever more ;—having, to a large extent, precisely the same instincts, with the additional power of looking down upon ourselves in this capacity from a higher elevation to which we can ascend at will. Not only are our bodily functions precisely similar to those of the lower animals,—some, like the beating of the heart, being purely "automatic" or involuntary—others being partially, and others again being wholly, under the control of the will—but many of our sensations and emotions are obviously the same with the sensations and emotions of the lower animals, connected with precisely the same machinery, presenting precisely the same phenomena, and recognizable by all the same criteria.

It is true that many of our actions became instinctive and mechanical only as the result of a previous intellectual operation of the self-conscious or reasoning kind. And this, no doubt, is the origin of the dream that all instinct, even in the animals, has had the same origin ; a dream due to the exaggerated "anthropomorphism" of those very philosophers who are most apt to denounce this source of error in others. But man has many instincts like the animals, to which no such origin in personal experience or in previous reasoning can be assigned. For not only in earliest infancy, but throughout life, we do innumerable things to which we are led by purely organic impulse ; things which have indeed a reason and a use, but a reason which we never know, and a use which we never discern, till we come to "think." And how different this process of "thinking" is we know likewise from our own experience. In contemplating the phenomena of reasoning and of conscious deliberation, it really seems as if it were impossible to sever it from the idea of a double personality Tennyson's poem of the "Two Voices" is no poetic exaggeration of the duality of which we are conscious when we attend to the mental operations of our own most complex nature. It is as if there were within us one Being always receptive of suggestions, and always responding in the form of impulse—and another being capable of passing these suggestions in review before it, and of allowing or disallowing the impulses to which they give rise.

There is a profound difference between creatures in which one only of these voices speaks, and man, whose ears are, as it were, open to them both. The things which we do in obedience to the lower and simpler voice are indeed many, various, and full of a true and wonderful significance. But the things which we do and the affections which we cherish, in obedience to the higher voice have a rank, a meaning, and a scope which is all their own. There is no indication in the lower animals of this double Personality. They hear no voice but one: and the whole law of their Being is perfectly fulfilled in following it. This it is which gives its restfulness to Nature, whose abodes are indeed what Wordsworth calls them—

"Abodes where Self-disturbance hath no part."

On the other hand, the double Personality, the presence of "Two Voices," is never wholly wanting even in the most degraded of human beings—their thoughts everywhere "accusing or else excusing one another."

Knowing, therefore, in ourselves both these kinds of operation, we can measure the distance between them, and we can thoroughly understand how animals may be able to do all that they actually perform, without ever passing through the processes of augmentation by which we reach the conclusions of conscious reason and of moral obligation. Moreover, seeing and feeling the difference, we can see and feel the relations which obtain between the two classes of mental work. The plain truth is, that the higher and more complicated work is done, and can only be done in this life, with the material supplied by the lower and simpler tools. Nay, more, the very highest and most aspiring mental processes rest upon the lower, as a building rests upon its foundation stones. They are like the rude but massive substructions from which some great temple springs. Not only is the impulse, the disposition, and the ability to reason as purely intuitive and congenital in Man as the disposition to eat, but the fundamental axioms on which all reasoning rests are, and can only be, intuitively perceived. This, indeed, is the essential character of all the axioms or self-evident propositions which are the basis of reasoning, that the truth of them is perceived by an act of apprehension, which, if it depends on any process, depends on a process unconscious, involuntary, and purely automatic. But this is the definition, the only definition, of instinct, or intuition. All conscious reasoning thus starts from the data which this great faculty supplies; and all our trust and confidence in the results of reasoning must depend on our trust and confidence in the adjusted harmony which has been established between instinct and the truths of nature. Not only is the idea of mechanism consistent with this confidence, but it is inseparable from it. No firmer ground for that confidence can be given us in thought than this conception—that as the eye of sense is a mechanism specially adjusted to receive the light of heaven, so is the mental eye a mechanism specially adjusted to perceive those realities which are in the nature of necessary and eternal truth. Moreover, the same conception helps us to understand the real nature of those limitations upon our faculties which curtail their range, and which yet, in a sense, we may be said partially to overpass in the very act of becoming conscious of them. We see it to be a great law prevailing in the instincts of the lower animals, and in our own, that they are true not only as guiding the animal rightly to the satisfaction of whatever appetite is immediately concerned, but true also as ministering to ends of which the animal knows nothing, although they are ends of the highest importance, both in its own economy and in the far-off economies of creation. In direct proportion as our own minds and intellects partake of the same nature, and are founded on the same principle of adjustment, we may feel assured that the same law prevails in their nobler work and functions. And the glorious law is no less than this—that the work of instinct is true not only for the short way it goes, but for that infinite distance into which it leads in a true direction.

I know no argument better fitted than this to dispel the sickly dreams, the morbid misgivings, of the Agnostic. Nor do I know of any other conception as securely founded on science, properly so called, which better serves to render intelligible and to bring within the familiar analogies of Nature those higher and rarer mental gifts which we know as genius, and even that highest and rarest of all which we understand as inspiration. That the human mind is always in some degree, and that certain individual minds have been in a special degree, reflecting surfaces, as it were, for the verities of the unseen and eternal world, is a conception having all the characters of coherence which assure us of its harmony with the general constitution and the common course of things.

And so this doctrine of animal automatism—the notion that the mind of man is indeed a structure and a mechanism—a notion which is held over our heads as a terror and a doubt—becomes, when closely scrutinized, the most comforting and re-assuring of all conceptions. No stronger assurance can be given us that our faculties, when rightly used, are powers on which we can indeed rely. It reveals what may be called the strong physical foundations on which the truthfulness of Reason rests. And more than this—it clothes with the like character of trustworthiness every instinctive and intuitive affection of the human soul. It roots the reasonableness of faith in our conviction of the Unities of Nature. It tells us that as we know the instincts of the lower animals to be the index and the result of laws which are out of sight to them, so also have our own higher instincts the same relation to truths which are of corresponding dignity and of corresponding scope.

Nor can this conception of the mind of Man being connected with an adjusted mechanism cast, as has been suggested, any doubt on the freedom of the Will,—such as by the direct evidence of consciousness we know that freedom to be. This suggestion is simply a repetition of the same inveterate confusion of thought which has been exposed before. The question of what our powers are is in no way affected by the admission or discovery that they are all connected with an apparatus. Consciousness does not tell us that we stand unrelated to the system of things of which we form a part. We dream—or rather we simply rave—if we think we are free to choose among things which are not presented to our choice,—or if we think that choice itself can be free from motives,—or if we think that we can find any motive outside the number of those to which by the structure of our minds and of its organ we have been made accessible. The only freedom of which we are really conscious is freedom from compulsion in choosing among things which are presented to our choice,—consciousness also attesting the fact that among those things some are coincident, and some are not coincident, with acknowledged obligation. This, and all other direct perceptions, are not weakened but confirmed by the doctrine that our minds are connected with an adjusted mechanism. Because the first result of this conception is to establish the evidence of consciousness when given under healthy conditions, and when properly ascertained, as necessarily the best and the nearest representation of the truth. This it does in recognizing ourselves, and all the faculties we possess, to be nothing but the result and index of an adjustment contrived by and reflecting the Mind which is supreme in Nature. We are derived and not original. We have been created, or—if any one likes the phrase better—we have been "evolved:" not, however, out of nothing, nor out of confusion, nor out of lies,—but out of "Nature," which is but a word for the sum of all existence—the source of all order, and the very ground of all truth—the fountain in which all fullness dwells.

ASTRONOMICAL NOTES.

ON THE DETERMINATION OF THE VALUE OF ONE REVOLUTION OF A MICROMETER SCREW, ETC.

To determine the value of a revolution of a micrometer screw, it is desirable to use several different methods. The most common and least accurate is by the observation of the transits of stars over two wires of the micrometer, set at a known distance (in revolutions) apart. Mechanical measures, depending upon the measurement of the length of the screw, of the dimensions of the objective, and of the principal focal length of the telescope come next. The measures in arc of terrestrial objects of known linear dimensions come next. Bessel's triangulation of